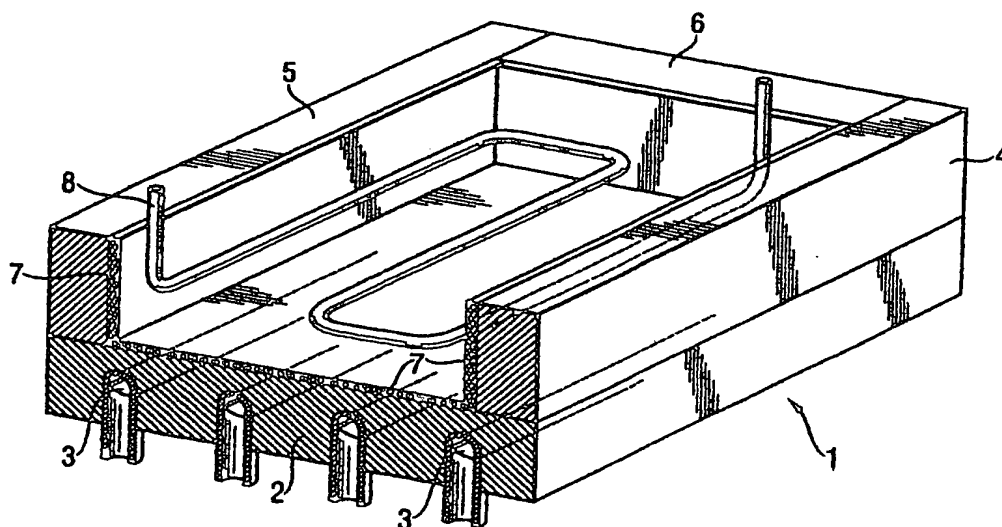


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<p>(21) International Application Number: PCT/FI00/00054</p> <p>(22) International Filing Date: 27 January 2000 (27.01.00)</p> <p>(30) Priority Data: 990198 3 February 1999 (03.02.99) FI</p> <p>(71) Applicant (for all designated States except US): OUTOKUMPU OYJ [FI/FI]; Riihitontuntie 7, FIN-02200 Espoo (FI).</p> <p>(72) Inventors; and (75) Inventors/Applicants (for US only): LEPPÄNEN, Yrjö [FI/FI]; Mikonkatu 30 A 25, FIN-28100 Pori (FI). MÄKINEN, Pertti [FI/FI]; Suulotintie 35, FIN-28610 Pori (FI). SALMINEN, Matti [FI/FI]; Ahjonkatu 9, FIN-20250 Nakkila (FI).</p> <p>(74) Agent: OUTOKUMPU OYJ; Patent Services, P.O. Box 27, FIN-02201 Espoo (FI).</p>	<p>(81) Designated States: AU, BG, BR, CA, CN, DE, ES, ID, IN, JP, KR, KZ, MX, NO, PL, PT, RO, RU, SE, TR, US, YU, ZA, Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).</p> <p>Published <i>With international search report. Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i></p>	

(54) Title: CASTING MOULD FOR MANUFACTURING A COOLING ELEMENT AND COOLING ELEMENT MADE IN SAID MOULD



(57) Abstract

The invention relates to a casting mould for manufacturing of a cooling element for a pyrometallurgical reactor, wherein the casting mould is at least partly cooled and lined with a material that can withstand high temperatures. The invention also relates to the cooling element made in the mould, inside which cooling pipes made of nickel copper are placed during fabrication.

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CASTING MOULD FOR MANUFACTURING A COOLING ELEMENT AND COOLING ELEMENT MADE IN SAID MOULD

5 The invention relates to a casting mould for the manufacturing of a cooling element for a pyrometallurgical reactor, wherein the casting mould is at least partly cooled and lined with a material that can withstand high temperatures. The invention also relates to the cooling element made in the said mould.

10 In pyrometallurgical processes, the brickwork of a reactor is protected by water-cooled cooling elements so that, due to the cooling effect, the heat coming to the surface of the brickwork is transferred via the cooling element to water, wherein the wear on the lining decreases considerably in comparison with a reactor not provided with cooling. The decrease in wear is caused by the result of cooling, a so-called autogenic lining, formed of slag
15 and other molten phases that attaches to the fireproof surface of the lining.

Traditionally, cooling elements are manufactured by two methods: Firstly, the elements can be fabricated by sand casting. In this method, cooling pipes made of highly thermo-conductive material such as copper are set in a
20 mould dug in the sand, so that during casting, there is cooling either by air or water occurring around the pipes. The element to be cast around the piping is also made of a highly thermo-conductive material, advantageously copper. This fabrication method has been described in for example GB patent 1386645. The problem with this method is the uneven attachment of the
25 piping that acts as flow channel to the surrounding casting material, since part of the piping may be totally detached from the element cast around it and part of the piping may be completely melted and therefore damaged. If no metallic bond is formed between the cooling pipe and the other element cast around it, heat transfer will not be efficient. If the piping melts
30 completely, it will prevent the flow of cooling water. The casting properties of the casting material can be enhanced by, for example, mixing some phosphorus into the copper, which will improve the metallic bond forming

between the piping and casting material, but in this way the heat transfer properties (thermal conductivity) of the cast copper deteriorate considerably with just small additions. Advantages of this method can be listed as the comparatively low fabrication costs and independence from dimensions.

5

A fabrication method has also been used, where glass piping in the shape of a flow channel is set into the cooling element mould which glass piping is broken after casting, so that a flow channel forms inside the element.

- 10 US patent 4382585 describes another, widely used fabrication method for cooling elements, according to which the element is fabricated for example from rolled copper plate, by machining the necessary channels. The advantage of this method is the dense, strong structure and good heat transfer from a cooling medium such as water to the element. The
- 15 drawbacks are dimensional limitations (size) and the high cost.

- Now a casting mould has been developed for manufacturing a cooling element for a pyrometallurgical reactor to replace the previous sand casting. The casting mould is constructed from separate, highly thermo-conductive
- 20 copper plates, of which at least some are water-cooled. Since the cooling element itself is in most cases copper, the construction plates of the casting mould should be isolated from the cast copper, and this occurs by lining the inner part of the mould with highly thermo-conductive material such as
- 25 graphite plate, so that the parts of the mould attach themselves to the surface by means of underpressure. Graphite prevents the melt poured into the mould from sticking to the surface of the mould. The cooling element casting mould is advantageously provided with a cope, so the casting can be done in shielding gas. Prior to casting, the cooling pipes necessary for cooling water circulation that are going to go inside the cooling element are
- 30 placed into the mould. This piping is preferably made of nickel copper pipe, because the melting point of Ni-Cu pipe is higher than the copper being cast around it and therefore there is no risk of the pipe melting during casting.

The essential features of the invention will become apparent in the attached patent claims.

5 The casting mould construction described in this invention offers the following advantages:

- Thanks to the cooled mould and graphite lining, a tight and fine-grained casting is formed, particularly at the base of the casting mould.
- The construction of the mould means that the cooling element forms a
10 smooth surface, which is not vulnerable to corroding smelting conditions.

The nickel copper used as the material for the cooling element cooling pipes facilitates a good welding of the piping to the actual element.

15 The construction of the casting mould can be developed further so that it can also be used for manufacturing cooling elements designed for special purposes. This occurs for example by adding graphite or fireproof shaped pieces to the mould, so that the finished element design differs correspondingly from the plated version.

20

The invention can be described further with the aid of the attached diagrams, where Figure 1 presents a principle drawing of the casting mould according to this invention and

Figure 2 shows the casting mould in cross-section, with which
25 special-purpose cooling elements can be cast.

Figure 1 shows a principle drawing of a cooling element casting mould 1. The mould is composed of a mould base plate 2, which is furnished with cooling pipes 3. The mould also has side walls 4 and 5 and end walls from
30 which only a back wall 6 is shown in the drawing. In the drawing, only the base plate is furnished with cooling pipes but, if required, the side and end walls can also be equipped for cooling. The front end wall has been left out



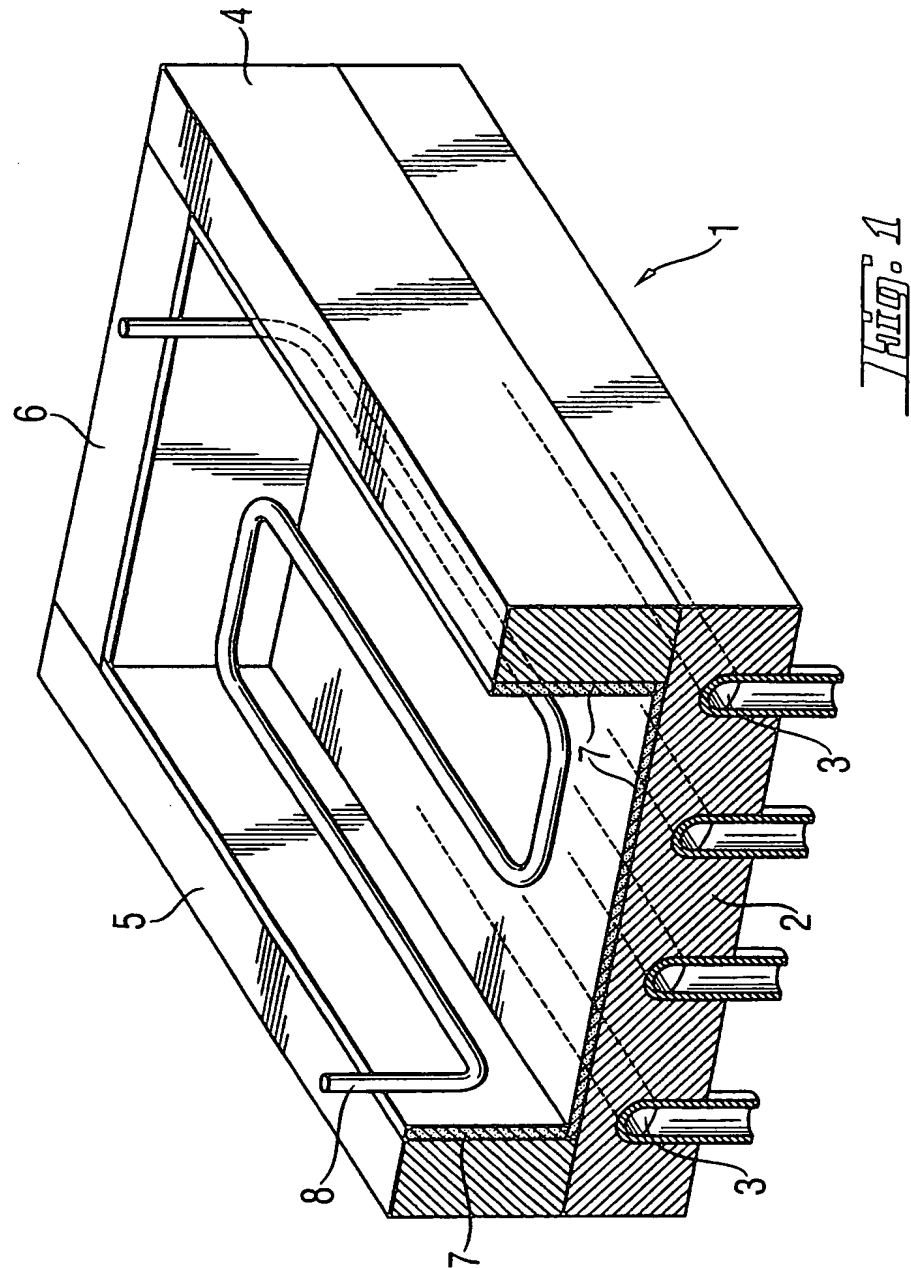
of the drawing for reasons of clarity, although it definitely belongs to the mould.

- 5 The inside of the mould is lined with graphite plates 7. The cooling element cooling pipes 8, which are advantageously made of nickel copper, are supported inside the mould. The mould is also equipped with a cope (not shown) so that shielding gas can be used to prevent oxidation of the element to be cast.
- 10 In Figure 2 it can be seen that shaped pieces 9 can be placed on the base of the mould, which are made of graphite or some other fireproof material. By means of these shaped pieces, the side 11, which will come into contact with mould base 2 of cooling element 10, can be shaped as desired.

PATENT CLAIMS

1. A casting mould formed of base (2), wall (4,5) and end plates (6) for manufacturing of a pyrometallurgical reactor cooling element,
5 **characterized in that** the casting mould (1) made of copper plates is at least partly equipped with cooling pipes (3) and that the mould is lined on the inside with a plate (7) resistant to high temperatures.
2. A casting mould according to claim 1, **characterized in that** the casting
10 mould (1) is lined with graphite plates (7).
3. A casting mould according to claim 1, **characterized in that** the plates
(7) resistant to high temperatures are fixed to the surface of the mould (1) by means of underpressure.
15
4. A casting mould according to claim 1 **characterized in that** shaped pieces (9) made of graphite or fire-resistant material are placed on the base of the casting mould (1).
- 20 5. A pyrometallurgical reactor cooling element fabricated in a mould, **characterized in that** cooling pipes (8), placed inside cooling element (10) are manufactured of nickel copper.
- 25 6. A cooling element according to claim 4, **characterized in that** during manufacturing of the cooling element (10), one side of the element (11) is formed by means of shaped pieces (9) placed on the base of the casting mould.

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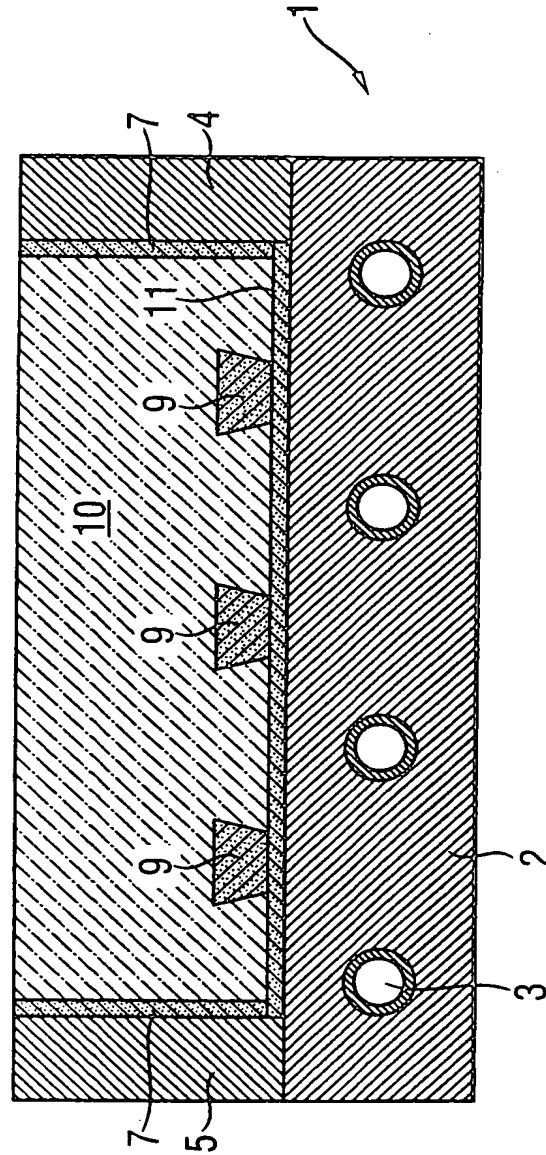


Fig. 2

INTERNATIONAL SEARCH REPORT

1

International application No.

PCT/FI 00/00054

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: B22C 9/24, B22D 27/04, B22D 19/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: B22C, B22D, F27D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search

28 June 2000

Date of mailing of the international search report

06 -07- 2000

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2

INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI 00/00054

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI00/00054

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).:

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

- I. Claims 1-4 relate to a casting mould made of copper plates.
- II. Claims 5-6 relate to a cooling element involving cooling pipes manufactured of nickel copper.

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
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Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
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INTERNATIONAL SEARCH REPORT

Information on patent family members

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International application No.

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